

TECHNO-ECONOMIC SURVEY OF KERALA

133 1.9 The distance within which these rivers descend to the sea level being very short, there are generally a large number of steep falls or a series of cascades in their courses. These provide a rich potential for generation of hydro-electric power, which can be generated at a low cost (1.7 nP per kWh on an average). This low cost power potential is an important asset of Kerala from the point of view of the future programmes of industrialization.

133 1.10 Some other implications of topographical features are not so obvious. For example, the lakes, the lagoons and the backwaters fringed with coconut palms, no doubt, impart to Kerala its characteristic scenic beauty and provide one of the chief tourist attractions. Their importance, however, goes much beyond the purely aesthetic aspect. In fact, the backwaters—especially in the Travancore-Cochin region—are indirectly responsible for providing the means of livelihood to a vast section of the population. Coir spinning, the chief industry of Kerala, is located in this State primarily because of the natural retting facilities provided by the backwaters. The availability of these facilities is unique in the case of Kerala. In almost all other coconut-growing areas of India, the coconut husks go waste because of the absence of natural retting facilities. Since coir industry provides an occupation to 4 to 5 lakh persons (about 10% of the total working force and 40% of industrial working force), one can well imagine what the unemployment situation in Kerala would have been in the absence of the backwater facilities. The backwaters have also facilitated the development of a wide network of inland waterways all along the coastline. Apart from employing a large number of persons in towing or rowing the boats, the inland waterways provide inexpensive modes of transporting the agricultural produce and light industrial goods manufactured in the coastal area.

133 1.11 Up till now only some of the favourable consequences of physical features have been pointed out. The sloping terrain and preponderance of backwaters in the coastal area also possess a negative aspect. The heavy downpour is gradually leaching off the mineral content of the soils, thus rendering them generally poor in their fertility status. One of its ultimate consequences is the fact that livestock feed available in Kerala is deficient in mineral content and this in turn reduces the yield of milk of the livestock. The heavy precipitation of rain also creates a serious flood control problem in Kerala.

133 1.12 The backwaters raise other problems as well. During the dry summer months saline water from these flows into the lower reaches of the rivers, many of which fall into the backwaters. This has an adverse effect on cultivation and the supply of drinking water in the coastal areas. Coastal areas are, therefore, beset with the problem of salinity control. The chain of consequences does not stop here. Recently implementation of one of the important salinity control measures in Kerala, viz., the Thanneermukkom bund across the Vembanad lake has created a new problem in its wake. The accretion of limeshell deposits, an important raw material found in the lake, depends on the high salinity of the lake water. Since, after putting up of the barrage salinity of water will get reduced, it will have adverse repercussions on the long run supply position of the limeshells. This, in turn, jeopardizes the long run prospects of the cement industry in the State which is based on the limeshells.

[Text continues on p. 6]

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STATE INCOME (RS. IN CRORES)—AT 1955-56 PRICES

	1955-56	1960-61	Proportional increase (per cent)
Primary Sector	172.5	193.2	12.0
Secondary Sector	32.3	62.6	19.7
Tertiary Sector	126.8	144.2	13.7
TOTAL	331.6	400.0	13.7
Per capita income	Rs. 234.4	Rs. 240.0	

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1.63 As a result of the various measures for increased agricultural production, the value added by this sector has increased but not by any spectacular amount. Output of rice increased from 7.5 lakh tons in 1952-53 to 8.7 lakh tons in 1955-56 and 9.8 lakh tons in 1959-60, the increase between 1956-60 being 8 per cent. Other important increases during the period 1955-56 to 1958-59 were: tapioca 15 per cent; sugarcane 3 per cent, arecanut 5 per cent, rubber 6 per cent, cashewnuts 22 per cent, coconut 3.2 per cent and bananas 120 per cent. On the basis of these increments in output and shift towards a superior cropping pattern, it is estimated that the net value contributed by the agricultural sector increased by about 10-12 per cent between 1955-56 and 1960-61. A rate of growth of 12 per cent is assumed for the whole of the primary sector over the Second Plan period.

1.64 Estimates of increase in the output of industry can be made only with the help of indirect indicators. There is generally a high correlation between increase in the consumption of electrical energy and output from the organized factory sector.

● [372] On the basis of data for the utilization of electric energy in industries, factory output has been estimated to have increased from Rs. 18 crores in 1955-56 to Rs. 24.4 crores¹ in 1960-61.

1.65 Non-factory sector output is estimated to have increased from Rs. 32.3 crores to Rs. 35.5 crores.² The rate of increase of output from the secondary sector as a whole, therefore, comes to be 19.7 per cent. The rate of industrial growth may have been higher but for the fact that during the Second Plan period industries could not develop at the anticipated pace as a result of non-execution of all the power projects planned earlier. Foreign exchange difficulties were the main obstruction in the way of implementation of Plans for power projects. Consequently effective

¹ During 1955-56, the relationship between factory sector output and electricity consumption works out to Rs. 0.8/kWh. According to NCAER's study *Demand for Energy in India* this coefficient is likely to decrease with the passage of time both as a result of the spread of power-using equipment and through the expansion of electric-intensive industries. By 1960-61, the co-efficient in case of Kerala is expected to have decreased to Rs. 0.65/kWh. The industrial consumption of electricity by 1960-61 is expected to have reached 376 m. kWh. On the basis of the co-efficient of Rs. 0.65/kWh, the output from factory sector is estimated to have reached Rs. 24.4 crores, by 1960-61.

² Non-factory sector output is assumed to have increased in the same ratio as gross purchasing power. Gross purchasing power depends upon rise in population as well as the rise in per capita income, that is, it is correlated with increase in over-all level of income. Since output from the non-factory sector mostly caters to the needs of the local village population, it is not very unreasonable to assume that output from this sector has increased at the same rate as income originating from agriculture, which roughly represents the level of purchasing power in the rural areas.

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capacity increased from 89.6 MW to only 100 MW during the Second Plan period. Total availability of electrical energy increased from 347.1 million kWh (1955-56) to 515 million kWh (1958-59) mainly through an increase in the load factor. ^{433*} [377]

1.66 Tertiary incomes generally grow at about the same pace as the commodity output, that is, output of the primary and secondary sector combined. Tertiary income is assumed to have risen at 13.7 per cent, the same as the State Income. On these premises projections for sectoral increase in the State Income (at 1955-56 prices) of Kerala have been given in table under paragraph 1.62. State income is expected to have increased by 13.7 per cent but most of this rise has been absorbed by the increase of population. Consequently the per capita income at constant prices is likely to have arisen from Rs. 234.4 (1955-56 prices) to only Rs. 240.7 in 1960-61. ^{433*} 434

1.67 This has been rather a slow rate of development. Obviously Kerala needs a higher rate of growth, much bigger plans that would generate it, and a strategy of development that would ensure it. These aspects are considered and discussed in the chapters that follow. The picture which emerges out of the aggregation of sectoral plans is discussed in Chapter 12 dealing with the pattern of growth. ^{433*} [28]

Chapter 7

Power

*433 KERALA HAS IMMENSE potentiality for the generation of hydro-electric power. The State does not possess any resource of coal or oil (within its own boundary) for generation of power but there are 44 rivers which constitute a storehouse of hydel power. This favourable factor compensates for the absence of any fossil fuels. Investigations so far have led to an estimate of this potential to be roughly of the order of 1,539 MW.¹

*433 7.2 One of the basic problems of Kerala's economy is posed by the situation of acute unemployment prevailing in the State. A long run solution to this lies in an intensive programme of industrialization only. An accelerated pace of industrial development, in turn, requires an ensured supply of adequate power. One possible way of looking at power development activities is to consider power as a complementary factor in the programme of industrialization of the State. Targets for power generation capacity in such cases should be fixed slightly higher than what the demand is expected to be.

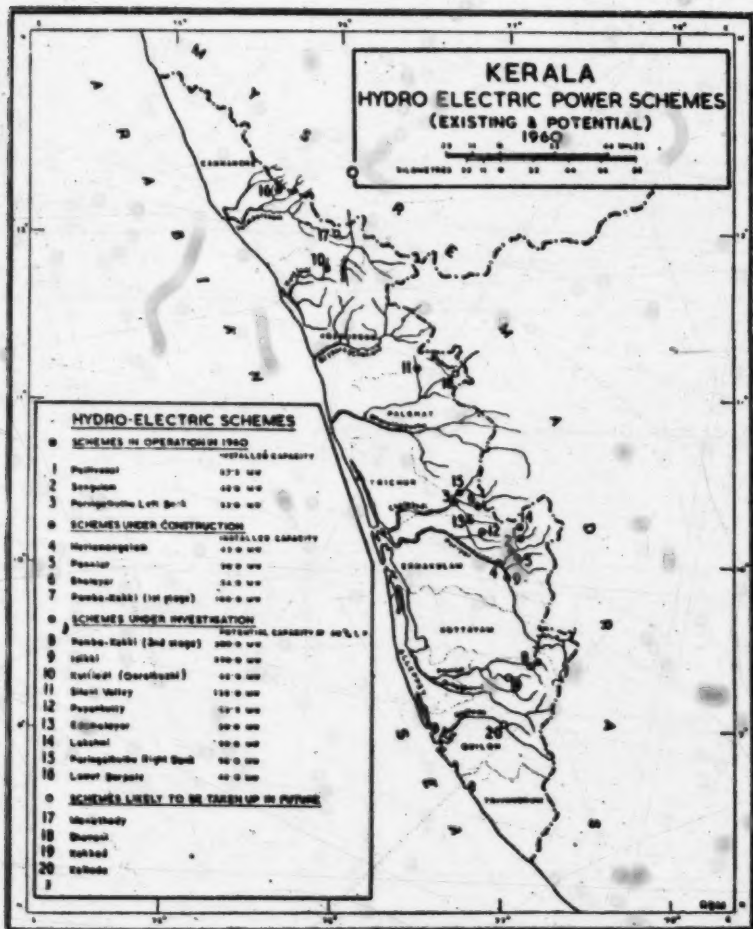
*433 7.3 The alternative approach, which is the more feasible one for Kerala, is to consider power, generation itself as an industry and to develop the State's abundant hydro-power resources to the maximum extent possible. The surplus of electricity generated over local requirements could be exported to the neighbouring State of Madras, which is not so well placed in respect of its power resources as Kerala. The electricity exported would provide a means of earning revenue, which in turn could be utilized for capital formation within the State. Moreover, a surplus in power generation capacity is desirable in itself since for a State like Kerala, where some factors deterrent to industrialization have been operating in the past, a regular supply of adequate power should be made to act as an incentive for setting up new industries. Planning for a power surplus and export of electrical energy to the neighbouring States should, therefore, form the keynote of the future power development policy in the State.

DEVELOPMENT OF POWER

7.4 The process of power development in the State is already well set. What is now required is to harness the huge energy potential of the State and convert it

¹ By the Central Water and Power Commission.

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433 into a useful commodity. If this is done, it is possible to visualize that from 1965
377 onwards the State can be made the seat of bulk hydro-power generation not only for
meeting the requirements of its own development programmes, but also for export
to neighbouring areas in the southern zone. During the coming decade activities
in connection with power development should, therefore, be geared mainly to the
need of achieving this objective.

Prior to the Plans

433 7.5 The beginning of an extensive power supply system, utilizing hydro-power
377 resources of the State, was first initiated with the establishment of the hydro-
655 electric power station at Pallivasal in 1940. During the years of the Second World
War the power system registered significant progress as a result of increased
industrial activity in the State. Just prior to 1951, the State had developed a
total installed capacity of about 33 MW, of which 14 per cent was in diesel
stations and the rest in hydel projects. A 66 KV transmission system covered
the State and power was distributed to about 28,000 consumers in 1958 towns and
villages.

First Plan Period

7.6 Out of a total Plan provision of Rs. 30.03 crores, the largest share
(Rs. 11.4 crores) was allotted to the development of power. Four hydro-
electric projects viz., Sengulam Project, the Poringalkuthu Project I Stage,
Poringalkuthu Project II Stage and the Nariamangalam Project, were taken
up. During the First Plan period, the Mattupatty Dam (of the Pallivasal
Project) with a storage capacity of 1,900 million cubic feet was constructed
for augmenting the summer flow to the Pallivasal hydel station. The installed
capacity of the station itself was raised to 37.5 MW providing for an effective
generating capacity of the order of 32.5 MW. The Sengulam Project was
commissioned in 1954 with an installed capacity of 48 MW. The Poring-
galkuthu Project, I Stage, was almost complete by 1956, and the remaining
two projects were taken up for execution only during the last year of the
First Plan. By 1956, the generating capacity had risen from 28.5 MW in 1951 to
85 MW, and the energy generated from 151 million units to 350 million
[365] units. Besides this, the transmission network was further expanded and 744
villages were electrified. An additional 51,456 consumers were connected to the
system.

Second Plan Period

7.7 The share of power was quite large in the Second Plan allocations. Out
of the total outlay of Rs. 87 crores, the allotment for power development alone was
Rs. 23.45 crores.

7.8 The total expenditure on power was made up of Rs. 11.40 crores for hydro

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electric projects, Rs. 4.82 crores for extension of transmission lines and Rs. 7.23 crores for rural electrification-cum-distribution schemes. The physical targets aimed at under the Second Plan were as follows. 423
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A. Additional Generating Capacity

(i) Poringalkuthu, I Stage	24 MW
(ii) Poringalkuthu, II Stage	8 "
(iii) Neriamangalam scheme	45 "
(iv) Sholayar project	34 "
(v) Panniar project	30 "

Total 181 MW

B. Transmission Lines and Sub-stations

(i) 110 KV lines	388 circuit miles
(ii) 66 KV lines	43 circuit miles
(iii) 110 KV sub-station	4 nos.
(iv) 66 KV sub-station	6 nos.

C. Rural Electrification and Distribution Schemes

(i) Villages to be electrified	1,344 nos.
(ii) Additional consumers to be served	105,260 nos.

7.9 The capital investment in the Second Plan, till the end of the year 1959, was nearly Rs. 18.75 crores. Almost all the essential items of plant and equipment had to be imported for working the power schemes included in the Second Plan. The foreign exchange component of the cost is of the order of 45 per cent. The difficulties experienced with regard to the availability of foreign exchange during the early years of the Second Plan affected the progress of the planned hydro-electric schemes in Kerala. Further, pending a decision on the riparian rights of Kerala and Madras regarding the waters of Poringalkuthu and Sholayar, the execution of Sholayar hydel scheme had been delayed. Only the Poringalkuthu II Stage extension could be completed by the end of the Second Plan. The first two units of the Neriamangalam scheme, having a total capacity of 30 MW, were also installed. In consequence, as against a much higher target that is, 246.5 MW, the total installed capacity in the system reached only 147.5 MW as shown by the breakdown below in the table :

INSTALLED CAPACITY IN MW

Name of Station	At the end of the First Plan (By March 1958)	Addition during the Second Plan (1958-61)	Total (By March 1961)
Pallivasal	37.5	Nil	37.5
Sengulam	48	Nil	48.0
Poringalkuthu I Stage	—	24	24.0
Poringalkuthu II Stage	—	8	8.0
Neriamangalam	—	30	30.0
TOTAL	85.5	62	147.5

7.10 Owing to non-commissioning of the Panniar and Sholayar projects, sufficient water was not available for running the machines to their rated capacity either at Poringalkuthu or Neriamangalam. Consequently, by the end of the Second Plan,

*433 effective capacity was only around 84.5 MW. This will rise sharply with the execution
377 of Panniar and Sholayar schemes during the early years of the Third Plan.

655 7.11 The position at the end of the Second Plan was as follows :—

Transmission, Distribution and Rural Electrification schemes had made good progress. The works which were completed include :

- (i) the 110 KV Sengulam-Pallom-Kundra double circuit transmission lines and the 110 KV sub-stations at these places;
- (ii) the 110 KV Neriamangalam-Always-FACT double circuit transmission lines;
- (iii) the 110 KV Sholayar-Poringalkuthu double circuit transmission lines;
- (iv) the 66 KV single circuit line from Viyyur and Palghat; and
- (v) the 66 KV sub-station at Peermade, Thiruvalla, Alleppey and Vythilla and 33 sub-stations at Karumagappally.

655 Besides a carrier communication system linking all the generating and receiving stations and the headquarters of the State Electricity Board was completed and taken into service. In the sphere of rural electrification, the benefit of electricity was further extended to 1,003 centres, additional 97,662 consumers were connected to the system and 57,282 street lights were installed in various parts of the State.

GENERATION AND UTILIZATION OF ELECTRICITY

*433 7.12 Table 33² summarizes the progress of electric power generation and utilization in the State of Kerala during the period 1954-55 to 1958-59. Some of the characteristics are worth noting. Of the total available electrical energy, about 20 per cent is lost in transmission and distribution or used for power station auxiliaries (all India 17.5%). Of the rest, as could be expected, industries are the most important consumers. They account for about 65 per cent of total electricity consumption in the State, the comparable proportion in the country being 50-55 per cent. Next in order of importance is domestic lighting which absorbs about 6.5 to 8 per cent (all India about 10%). The proportion of power used for irrigation has varied between 2 and 4 per cent of the total. Pumping out of water from the water-logged areas of Kuttanad is one of the main source of utilization of electricity in the sphere of irrigation.

7.13 Apart from these, two other important points may be noted : (i) Practically all the energy generated (97.98%) is from the hydro-electric power stations. This is in marked contrast to the pattern of power generation in the rest of India where roughly 55 per cent of electricity is from thermal sources. However, unlike the rest of India where it is necessary to have thermal stations to stabilize supply of power throughout the year, in Kerala because of an exceptionally well distributed rainfall and consequently assured supply of water over the different seasons, there is no such necessity and (ii) It is significant that the load factor has been steadily increasing during the recent years. The units generated annually per kW of installed capacity reached a figure of 4,400 during 1958-59 from 3,200 in 1954-55, that is, the load factor increased from 37 per cent to 46 per cent. Additional demand for power since 1954 has been met, almost entirely, by more intensive utilization of the existing capacity.

²[Table 33, appearing on p. 292 of the text, has not been processed -- Andhy.]

As explained earlier, the effective capacity could not be increased beyond 84.5 MW mainly on account of foreign exchange difficulties. K33*
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7.14 The relative shares of various consumers in the coming years will naturally depend on the pace of economic development. Nevertheless, it can be reliably forecast that the relative proportions will not significantly change and industry will retain its predominant place since it is expected that the industrial development will continue to be considered the pivot for economic growth of Kerala.

7.15 Per capita consumption of electrical energy in the State was about 27.75 kWh in 1959-60, which was slightly less than the all-India level of 30.45 kWh.

Regional Distribution of Electricity Facilities

7.16 There is some imbalance in the distribution of electricity in Kerala. The southern districts which were part of the former progressive State of Travancore-Cochin, are more developed from the standpoint of industry and power, whereas the northern districts constituting the Malabar area are comparatively backward. The relative position of different districts in this regard is indicated in Table 34. 377
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7.17 Similarly, the network of transmission and distribution lines also depicts a concentration of electrical facilities in the south or south-central region. Naturally, this has led to a clustering of industries in this area. However, it is possible to even out the position in future by undertaking the extension of transmission lines to the northern parts of Kerala as well. The present programme of extending 110 KV line to the north is a step in the proper direction.

Cost of Power Generation

7.18 One of the outstanding features of power development in Kerala is the low cost of generation. Generally investment per kW of installed capacity is higher in the case of hydro schemes than in the case of thermal power stations. In Kerala, however, the figure for investment per kW of installed capacity is Rs. 750 to Rs. 900 for hydro schemes which is no higher than in the case of thermal stations. Most of the hydro sites are still unexploited and are ideally suitable for hydel generation. Since the catchment areas of hydel projects receive rain from both the south-west and north-east monsoons, the storage capacity required per kW of generating capacity is relatively small which in turn reduces the overall capital cost per kW. It is because of these factors that the initial investment normally incurred in case of hydro-electric schemes in Kerala, excluding transmission and distribution, is as low as Rs. 750 to Rs. 900 per kW of installed capacity against the all-India average of Rs. 1,500 to Rs. 2,000. Not only investment per kW of installed capacity is about the same for hydro and thermal projects in Kerala, the foreign exchange component of investment on hydro schemes up to generation, will also be of the order of only 25 per cent whereas in case of thermal schemes it is about 50 to 60 per cent. 377
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7.19 Since the capital cost of hydro-power in Kerala is exceptionally low, the average cost of generation from the existing hydro stations is only 1.7 nP per unit. In the case of schemes under execution as well as the schemes already investigated,

2 [Table 34, appearing on p. 293 of the text, has not been
processed - - Analyze]

- 377 the cost of generation as estimated at present would rarely exceed 2 nP per unit.
 435 As against this, the cost per unit of thermal power is estimated to vary between 6 nP to 10 nP for stations which are far from coal fields, as would be the case if Kerala were to go in for thermal generation. Table 35 presents some factual data regarding the cost of hydro-power generation.
- 377 7.20 Development of thermal power resources sometimes becomes necessary as
 132 a stabilizer for fluctuations in generating capacity of hydro dams caused by variations in the extent of rainfall. This problem does not arise in case of Kerala since a high level of rainfall which, in addition, is fairly well distributed over the year, is practically assured. As pointed out in another chapter, the co-efficient of mean deviation for annual rainfall in the case of Kerala is one of the lowest in the whole of India.
- 371 7.21 On account of these factors, electric energy from hydro resources would continue to occupy a predominant place in Kerala. The possibility of generating nuclear power within the foreseeable future can almost be ruled out for Kerala. Investment in nuclear power stations is of the order of Rs. 1,800 to Rs. 2,500 per kW of installed capacity, which is higher than those for thermal and hydro stations. Since Kerala has plenty of untapped hydro-power potential, the question of using nuclear energy does not arise.

DEMAND FOR AND SUPPLY OF POWER

- 377 7.22 The simultaneous maximum demand, as recorded on the State electricity
 1439 system, reached a peak of 94 MW during September, 1960. Over and above this, purchase from Madras State for Kerala system was about 8.6 MW and from Kerala to Madras was about 2.6 MW. So the net draw from the Madras system during September, 1960, was of the order of 6 MW. Hence the latest recorded demand on the State may be taken to be of the order of 100 MW during September, 1960, as against the available firm capacity of 84.5 MW.
- * 433 7.23 In this context, an independent forecast may be attempted here on the basis
 377 of projections for industrial output made in the chapter on Industries. Factory sector is the main industrial consumer of electricity accounting for roughly 65 per cent of energy generated. The net output of factory industry is projected to increase from Rs. 24.4 crores in 1960-61 to Rs. 89.2 crores in 1970-71. In 1955-56, power consumption by industries corresponding to net factory output of Rs. 18.40 crores was 224 million kWh. In other words 1.24 units of electricity were used to produce one rupee worth of net output in industries. The corresponding ratio for the country was 0.8 kWh/Rupee. The relatively higher coefficient in Kerala reflects the more
 1228 power-intensive industrial structure. This is mainly due to the location of aluminium and other electro-chemical industries in Kerala.
- 7.24 According to NCAER's projections¹, the power intensity of industries may be expected to increase both as a result of the spread of power-using equipment and

[143] ¹ Demand for Energy in India (1960-75), NCAER.

² [Table 35, appearing on p. 293 of the text, has not been processed - Analyst]

emergence of new power-intensive industries, from 0.8 kWh/Rupee in 1955-56 to 1.7 kWh/Rupee in 1970-71. Considering that power-intensive industries like aluminium will not grow as fast as the other less power-intensive lines of manufacture, the power coefficient is not likely to increase as rapidly in Kerala as in the rest of India. Assuming that in 1970-71 2.0 kWh of power would be needed on the average to produce one rupee worth of output in the factory industry, the projected net output of factories in that year, viz., Rs. 89.2 crores would require about 1,750 million kWh. 433* 377 ●

7.25 Assuming that the industries still account for 65 per cent of total energy consumption, total demand for energy in 1970-71 would be nearly 2,700 million kWh. This corresponds to 675 MW of generating capacity considering that 4,000 kWh are generated per kW of capacity. Simultaneous peak demand for energy by 1970-71 may be taken at 675 MW.

7.26 The probable phasing of this demand necessarily involves a certain amount of conjecture. If it is assumed that Kerala's power consumption increases at roughly the same rate as in all-India, the demand for energy would reach about 1,000 million kWh by 1965. However, in view of the fact that there is already unsatisfied demand for about 40 MW, and since the availability of power is one of the main means by which the State can attract industries, Kerala would be well advised to plan for a faster rate of power development during the next five years. Tentatively, simultaneous peak demand for 1965-66 is estimated to be 350 MW. Installed capacity may be about 15 per cent, higher than the simultaneous peak demand. The results are tabulated below :

	1965-66 (MW)	1970-71
Simultaneous peak demand estimated	350	675
Approximate installed capacity required	400	800

The Kerala State Electricity Board has estimated that the demand for power within the State by 1965-66 will be about 365 MW. The installed capacity of 400 MW as suggested above should be adequate for this demand.

7.27 To meet a peak demand for 350 MW by end of the Third Plan and 675 by end of the Fourth Plan, installed capacities of 400 and 800 MW will have to be built up to have effective capacities equal to simultaneous peak demand. This will be the requirement of Kerala alone and any demand from the south zone including that of Madras State will have to be added to this figure to arrive at the overall installed capacities to be built up.

7.28 In the sphere of transmission it appears necessary to build a high tension trunk line of 110 KV or higher throughout the length of the State from north to south. This will facilitate interchange of power amongst various hydel stations and thereby help to reduce the standby capacity. This is also expected to bring down simultaneous peak demand in the State by taking full advantage of diversity in different loads. The State Electricity Board is already at work on this line.

PROSPECTS DURING THE THIRD PLAN

*333 7.29 The total allocation of the Third Plan for the State is fixed at Rs. 170 crores and the outlay for power is fixed at Rs. 43.56 crores. According to the proposals for power development under the Third Plan, the implementation of the spill-over schemes of Panniar, Sholayar and Sabarigiri (Pamba-Kakki) will be the principal developmental activity during the Third Plan period. With the completion of these schemes, the installed capacity in the State will rise to 546 MW. Two new hydro-electric schemes, viz., Kuttiadi in North Malabar (installed capacity 75 MW) and Idikki Hydro-Electric Scheme (installed capacity 500 MW) are also proposed to be taken up during the Third Plan period. The Idikki scheme has been planned with the long range power requirements in view. Due to these continuing schemes, the total installed capacity available at the end of the Fourth Plan is expected to be about 975 MW.

7.30 An intensive rural electrification scheme has been programmed for the Third Plan. It will extend the benefits of electricity to about 750 more villages in the State. This, if fully implemented, will bring the total number of electrified localities to 3,100 by the end of the Third Plan. The distribution schemes during the Third Plan are expected to connect 100,000 new consumers and install 40,000 street lights.

FUTURE OF POWER DEVELOPMENT IN KERALA

7.31 Three important factors have to be taken into account in considering the future of power development in Kerala. (i) In view of the heavy pressure of population on agriculture and acute unemployment in the State, rapid industrialization is essential which in turn requires an abundant low cost power generating capacity; (ii) shortfalls in the supply of electric power should be avoided or at least minimized during the next five years, and (iii) Kerala has not only abundant hydel resources but it is also possibly the only State in the South which is likely to have a surplus in hydro-power potential.

Zonal Integration

7.32 Since during the next decade Kerala is likely to be the only power surplus State in the South, zonal integration should form the keynote of its power planning. It is expected that if implementation progresses according to Plans, by the end of the Third Plan period, Kerala will be able to have a surplus of power of about 150 MW over its own requirements. This will gradually go down until the spill-over schemes in the Fourth Plan start materializing. This surplus of 150 MW will then be steadily maintained and can be exported to the neighbouring State on a permanent basis so far as power development is concerned. Mysore and Andhra can, at best, remain on the fringe of self-sufficiency, at least for the next two decades, and Madras would have practically harnessed all its power resources by 1965-66. True, Madras has sizable lignite resources, but in view of manifold uses of lignite in industry, its utilization for

power generation will naturally be restricted. It is, therefore, essential that in the interests of the national economy, hydro-power generated at low cost in Kerala flows abundantly, and in bulk, to Madras State. 433* 377 ●

LIMITATIONS AND OBLIGATIONS OF EXPORT SALE OF POWER

7.34 The generation and export sale of the surplus electricity potential of the State, as a business proposition with a definite profit motive, just like any other industrial undertaking, has certain limitations and obligations which should be understood in advance. It is not as if this surplus generation places the State in a comfortable position of meeting any unanticipated demands of sizable magnitudes within the State itself at any time and gives it the option to export only whatever is in surplus to its needs from time to time. Export commitment is a definite contract and, except in the case of valid *force majeure* conditions, contractual obligations have to be met even when there is an acute power shortage within the State itself due to normal causes of development. Electricity industry is capital-intensive and involves the use of sizable foreign exchange for capital equipment. Electricity projects also take a long time to materialize. In a planned economy for the country as a whole, the available resources are equitably distributed for maximum regional growth. Therefore, when the economic surplus power potentials of the State are exploited for export to the neighbouring State, on considerations of overall national economy, corresponding provision for power generation in the neighbouring State is at the same time avoided and it is made to depend on import of power for its needs. These long-term commitments have, therefore, to be firmly and clearly understood in advance. 433* 377 439

Rates for Export Sale of Power

7.35 Viewed as a commercial proposition, the maximum price which can be demanded for this exported power will have to be just less than what it would have cost the neighbouring State if it were left to its own costly thermal generation. In addition, the selling State should surrender a small prefixed margin of its profit to the purchasing State in order to make the purchase attractive and worthwhile. In the case of Madras, there can be no difficulty at all. It will have to pay for Kerala power what it pays for Neyveli power. There is also an added advantage for Madras in taking Kerala power at thermal rates. Neyveli will give only a firm power all through the year and can serve only as a base load station. Excepting the hydro stations in Nilgiris, all other hydel stations of Madras are tied up with irrigation regulations and the varying seasonal outputs have to be largely firmed up by an integrated operation of all these stations. There are limitations in this when seasonal power growth tends to assume sizable proportions and the full utilization of the seasonal discharges for power generation may not be possible. Luckily the position is different in Kerala. The large hydro potentials of Kerala are predominantly for power generation. Integrated operation of the hydel stations of Kerala with the Madras grid is possible and it can effectively firm up the seasonal power potential of Madras State. This will also

result in mutual advantage to both the States and optimum exploitation and utilization of the water resources of the region as a whole. Kerala can thus give Madras varying power through all the seasons of the year and effectively firm up the seasonal power potential of the State. This operational aspect has also to be kept in view while planning projects for an integrated operation and export of surplus power of Kerala to Madras. Hence, Kerala power at average kWh rates of Neyveli supply, is more advantageous to Madras than Neyveli power. It benefits Kerala also.

Rates for Sale of Power to Consumers within the State

7.36 From the economic standpoint, the use to which power is put is just as important as its production. The two chief aspects of electricity consumption are: (i) Consumption of electricity as a factor in production in the field of industry, agriculture and traction. This can be termed "productive" power, or power in relation to productivity which activates the production and distribution circuits on which the increase of a country's wealth depends. (ii) Consumption of electricity for the direct, collective and individual needs of the people that is energy as a consumer good. This can be termed "non-productive" power.¹

7.37 In Kerala, productive consumption (industrial power, irrigation and agricultural de-watering) formed about 85 per cent of the total in 1959-60 and non-productive power (domestic, light and small power commercial light, and small power public lighting and water works) formed the remaining 15 per cent. The domestic consumption alone came to about 10.7 per cent. The corresponding figures for all-India (1959-60) were 77.9 per cent (productive), 22.1 per cent (non-productive) and 11.1 per cent (domestic consumption alone). But this small percentage of non-productive consumption contributed much more (than its reasonable share to the total revenues) from the sale of power.

7.38 For ready comparison, the consumption of energy distributed by Kerala State Electricity Board to its consumer within the State (i.e., excluding bulk supplies to Distributing Licencees and to the neighbouring Madras State) and the revenue thereof are given in Table 36 for the year 1957-58. The statement is revealing.

¹ "Productive" power helps to raise the standard of living of the community while "non-productive" power rather serves to measure the standard achieved. The rate-fixing policy must take into account these two distinct categories of consumption. Generally speaking, the policy should be one of cheap "productive" power for such productive cycles as would lead to a rise in wages so that it would then become possible for "non-productive" power to be sold at normal rates. In fixing higher rates for "non-productive" consumption, the ultimate objective of raising the standard of living of the community as a whole should not be lost sight of. The rate itself should not be unduly high to deny the service altogether to the bulk of the community living in an electrified locality. To this end, the rate fixed for "non-productive" power should also take into account the capacity of the community to pay. One of the objects of a sound rate-fixing policy would be to maintain within a given community a reasonable relation between "productive" and "non-productive" power consumption. Both in productive and non-productive uses of electricity where power replaces labour, power consumption will rise in proportion to its cheapness as compared to the cost of labour. In other words, the potential expansion of power consumption in a region may to a certain extent, be measured by the ratio of labour costs to power costs in the area. A policy of power expansion, if the costs remain high in relation to the cost of labour, cannot, therefore, achieve all the desired beneficial results; lowering of power costs, therefore, becomes more imperative where labour is cheapest.

2 [Table 36, appearing on p. 299 of the text, has not been processed -- Analysis]

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Eleven per cent non-productive consumption contributes nearly 60 per cent of the total revenue. This is much more than its reasonable share. This amount of subsidy cannot be easily justified. Domestic consumption alone forms only a little over 7 per cent of the total consumption, contributes over 51 per cent of the total revenue from the sale of power. This is much too high a share. 433* 377 651

7.39 There was a small, generally upward, revision of rates in December 1958, without materially altering the structure of the tariff. The above conclusions, therefore, still hold good. 433* 377 435

7.40 Amongst the non-productive classes of load, item iv (Table 36) Public Water Works and Sewage Pumping is billed at "Industrial Rates" and classified as industrial loads for the purpose. In respect of item iii (Table 36) Public Lighting, the revised tariff of December, 1958 provides a rate of "15 nP per kWh for lamps for the first 6 hours of burning and 12 nP per unit for the remaining hours". This rectifies the high average rate per kWh in 1957-58, as seen in the above statement. The average unit rate per kWh of domestic consumption comes to as much as seven times the average selling rate of the total consumption through all categories of load. It is 15 times the average rate for productive consumption. The tariff revision of December, 1958 does not relieve this position. This is important. The structure of the domestic tariffs could induce optimum utilization of installed capacity with better load factor, but the domestic rates themselves have to be reduced substantially. In a State which leads the rest of the country in economic power generation, this should not be difficult. The "power surplus" position of the State can also enable the State to take effective steps to make cheap power (though costlier than productive power) available for domestic consumers extensively and may substantially raise the total domestic consumption to a higher level. In the light of the above observations, it is recommended that the State should review and revise its tariff policy for power sales.

POSSIBILITY OF POWER SHORTAGE

7.41 It is learnt that power shortage is adversely affecting some of the existing big industries which are heavily dependent upon adequate power supply for their full production. Besides, starting of new industries may be hampered unless adequate power supply is forthcoming, or at least, the present power shortage is removed. 433* 377

7.42 A careful analysis of the power situation in Kerala shows that there will be no danger of a prolonged serious power gap. On the generation side, according to the present plans the Panniar Power Station with an installed capacity of 30,000 kW and the Sholayar Power Station with an installed capacity of 54,000 kW are expected to be commissioned in 1963 and 1964 respectively. Two of the six generating units of 50,000 kW each in the Sabarigiri (Pamba-Kakki) Power Station are also expected to be commissioned by the end of 1964 by which time the State will reach a very comfortable position in regard to power supply.

7.43 Any suggestion for setting up thermal power stations in the State to bridge the likely gaps in power supply will have to be examined in this context. As already pointed out, thermal power generation costs more, both in terms of the cost of genera- 433* 375

*433 tion and foreign exchange requirements. Besides, the construction of a thermal
375 station even if immediately taken up, cannot be completed before 1:20 to three years. This time lag considerably reduces its value for alleviating the immediate problem of power shortage. Under such circumstances, there is no case at all for considering any thermal power stations in Kerala.

*433 7.44 At present, the best solution would be to arrange for the staggering of power
● 377 load and to encourage the working of industries during the off-peak hours. Another possibility is that the Governments of Kerala and Madras may get together to alleviate the power problem of Kerala to whatever extent it is possible through the zonal grid.

INVESTMENT REQUIREMENTS

7.45 Kerala's installed capacity by the end of the Second Plan was 147.5 MW. To build it up to 400 MW by the end of the Third Plan as suggested in this report an additional installed capacity of roughly 250 MW will be necessary. According to current estimates, approximately Rs. 1,600 per kW will be required in Kerala for generation, transmission and distribution. On this basis, about Rs. 40 crores will be required during the Third Plan. During the Fourth Plan, installed capacity is envisaged to increase from 400 MW to 800 MW. At the same rate of investment per kW as mentioned above, investment requirements for the Fourth Plan would be about Rs. 64 crores. Thus Kerala State would require the sum of about Rs. 104 crores over the Third and Fourth Plan periods to satisfy its own power needs. Requirements of neighbouring States for Kerala's power would require additional investment over and above this figure.

CONCLUSIONS

7.46 The abundant water resources of the State, which can be utilized for generation of hydro-electric energy, form one of the strong points of Kerala economy. Apart from the large hydro-electric potential which is estimated to be of the order of 1,589 MW, the important feature of power resources of Kerala is the low cost of generation per unit. This is due to the favourable nature of the terrain and the high degree of rainfall which Kerala receives.

7.47 In the absence of any coal or oil deposits in Kerala or in nearby regions, hydro-electric power has to be the chief source of energy requirements of industry. The favourable position of Kerala in this respect should be utilized as a factor helping industrialization. For this purpose harnessing of the hydro-electric potential should be properly planned in advance so that an adequate amount of well-assured electric supply could be guaranteed to the industrialists. In this context the State would be well-advised to plan for a power surplus.

[439] 7.48 In view of the fact that Kerala is in a position to generate electric energy in excess of its requirements, while the neighbouring State of Madras has almost exhausted its domestic resources and Mysore and Andhra are just on the verge of self-

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sufficiency, Kerala should play the role of a net exporter of electric energy to these States. A zonal grid which is now planned to be laid in the South, is essential to make the most economic use of the power generating potential of the Southern States. Since the cost of electric generation is much lower in Kerala than in Madras or the other neighbouring States even after including transmission costs, Kerala may also be in a position to earn net revenue through export of electrical energy to the neighbouring States. This revenue could be utilized for capital formation within Kerala.

7.49 The State should review and revise its tariff policy for power sales specially with reference to consumption of power for domestic purposes.

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Literary and place-name evidence points to continuing growth of the land within proto-historic or even historic times. It seems likely that there were at least two phases of relative upward movement, represented by erosion surfaces in the laterite at around 250 and 600 ft, while the last stage—that reflected in legend and literature—added the eight miles or so between the existing shore and a line of villages of whose names 'sea' or 'island' is a component; some places mentioned by Ptolemy as sea-ports now lie at a similar distance inland. But all these are near the great Cochin backwater, which suggests—as do the large-scale maps—that normal prograding on a low shoreline of emergence is responsible for this accretion, rather than an actual change of levels. Probably associated with this are the Malabar mudbanks, which lie off all the river mouths. They are up to eight miles long, and their extremely finely comminuted lateritic mud forms as it were an emollient which deadens the ocean swell; in their lee are safe roadsteads for the small ports of the coast.

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The general tripartite longitudinal division is found: alluvial coastland, low lateritic plateaus and foothills, gneissic highlands. The division is indeed rather more clear cut than in the more complex Nn lowlands, but each zone has certain peculiarities. In the alluvium is the great development of lagoons and backwaters, saline or fresh, which, with some artificial cuts, form splendid waterways for some 150 miles from the Ponnani mouth to Trivandrum. The largest of these, behind Cochin, widens out Swds into Vembanad Lake. The laterites (including the ?Pliocene Warkalais) form plateaus at 200–600 ft, with much grass and scrub; into them project spurs of the Anaimalai-Cardamom Hills which, S of Palghat, have a very strong SE–NW trend, shown by the Periyar Valley. The hills themselves, rain-swept and forested, will be treated in the next chapter, but it may be noted here that the plantation agriculture of Kerala is confined to them, and the development of hydro-electricity from Pallivasal is of great importance to the agriculture and industry of the lowland.

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The Ponnani, the headwaters of which rise on the Nn slopes of the Anaimalais, leads up to the Palghat Gap, nearly 20 miles wide and not much over 1100 ft on its broad sill, which lies beyond the regional limits. Farther S the higher (nearly 1500 ft) and much narrower Shencottah Gap gives access to the extreme S of Madras. It is noteworthy that in both these gaps there were exclaves of Cochin and Travancore territory, extending well E of the watershed in the latter; these, with the ancient walls across the Comorin lowland, emphasise the importance of these sole easy points of contact between Kerala and Tamilnad.

Climate and Agriculture

The climate represents the nearest approach in India to equatorial conditions. Maximum temperatures rarely exceed 90° F., minima rarely fall

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Other Occupations

Fishing, both sea and freshwater, plays a big part in the life of Kerala but, as usual in India, is primitive in technique and organisation. It has, however, some interesting features: Portuguese influence is obvious in the so-called 'China nets' and the crossbow used for shooting fish from river-banks, " and there are many varieties of basket-work fish-traps. The catch of 'sardines' is largely used for manuring coconut; prawns are taken in flooded paddy-fields, the skins used as manure and the pulped flesh exported. Normally Burma was a good customer for prawns; the time of transport raised no difficulty as a high degree of putrescence was regarded with favour.

Travancore has a hydro-electric plant at Pallivasal on the Mudrapuzha River, with a capacity of 21,000 kW which can be increased to 36,000. The power is used for the industries of Cochin town and Ernakulam, of which the production of soap and cosmetics from copra is the most important. It also powers the sole Indian aluminium works, at Alwaye, formerly dependent on imported alumina but now increasingly supplied from Muri in Bihar (591 above); and a recent development is the use of electric pumps for 'de-watering' the *cole* lands. The great reservoir impounding the Periyar headwaters was built to supply irrigation water, by tunnel, to the Madras side, but may possibly be developed for power in the future.

Except for local clays and laterite, the only mineral deposits are the ilmenite, monazite, and zircon sands of the Travancore beaches from Quilon to Cape Comorin. These contain 8-10% thorium oxide and were exploited for the manufacture of gas mantles; the spread of electric lighting ruined this demand, but there has been a remarkable recovery. Titania from the ilmenite and cerium from the monazite are essential to some highly specialised electrical and chemical manufactures (electrodes, tracer bullets, and as a catalyst in benzine synthesis, amongst others) and recent developments in atomic research have made these deposits of great strategic significance. Production, which in 1925 fell to one hundred-weight of monazite, amounted in 1944 to 200,000 tons ilmenite, 2000 monazite, and 1600 zircon.

Population and Settlement

Population problems are very serious in Kerala; the density of Cochin in 1941 was the highest for any political unit in India—953 on a total area of 1493 sq mls—locally reaching 2000-4000 in a purely rural environment. Elankunnappuzha village had in 1941 no fewer than 18,173 people on its 3.8 sq mls—a density of 4782. The rate of increase has been very high—for

" A. K. Menon, "Fisheries of Cochin" (IGY XIV (1939)), 229-36; C. D. Forde, *op. cit.*, 369.

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rain. Above the rubber, tea extends to nearly 6000 ft, and indeed more than half of it is grown above 4000 ft; rainfall is usually 100-150 ins. It is noteworthy that over half the rubber is produced on Indian-owned estates, but only a small fraction of the tea.

As for hydro-electricity, the hills are dotted with falls and rainfall on the Wn flanks is everywhere high and reliable. So far the most important large development is at Pallivasal in Travancore (installed 21,000 kW, potential 36,000), which powers the aluminium smelters at Alwaye and also works pumps draining the flooded paddy-fields of Kerala. A project of great interest is that for utilising the great Periyar Reservoir (Fig. 150) for power. The Periyar headwaters have been impounded and are taken through the watershed by tunnel to irrigate the Suruli-Vaigai Valley in Madura; some 40,000 kW might be developed, and altogether the region has a potential of at least 200,000 kW.

The Wn flanks of the hills are too rain-swept to have much settlement except on plantations, forest camps, and power installations. In the E Kodaikanal, lying at 7000 ft on the Palnis, is a minor hill-station, noted for its mission schools and an old-established physical observatory.

Maharashtra

Maharashtra, the Maratha country *par excellence*,⁵ may be taken as roughly coterminous with the main mass of the Deccan Lavas above the Ghats. To the N the Tapti Valley, flanked by typical lava plateaus but floored by alluvium, forms a transition to the central Indian scarplands; in the S, along the Malaprabha, there is another belt where Archaeans and lavas interdigitate and where cultural allegiance is divided between the Marathi and Kannada (Kanarese) languages. But to the E, in Hyderabad especially, the boundary of Marathi speech shows a striking accordance with the edge of the Lavas (Fig. 127); hence the division of the state into Marathwara and Telangana, a rare instance of official recognition of regionalism. This great area thus includes all central Bombay, the NW third of Hyderabad, and SW Madhya Pradesh (CP) as far as Nagpur.

The Terrain

It is a region of extraordinary physical homogeneity, in the gross at least, although (as Deshpande points out) detailed study would undoubtedly reveal significant differences in erosional features, soils, vegetation, and farming practice depending on the varying petrology of the lavas. The general slope to the E and SE is gentle: Poona lies at 1800 ft, and it is over 100 miles down the Bhima to the 1500-ft contour. From the Ghat culminations long tongues of higher ground (over 2000 ft) run E and divide the plateau

⁵ The etymological connection of Maratha or Mahratta and Maharashtra, if any, is still controversial.